REVISED COMMENTS ON THE 1986 SURGEON GENERAL'S REPORT, THE EPA DRAFT RISK ASSESSMENTS, THE NIOSH CURRENT INTELLIGENCE BULLETIN, AND OTHER RISK ASSESSMENTS ON ETS

The conclusions of reports by three governmental agencies have been extensively relied upon by various organizations and individuals in discussions of health effects purportedly associated with environmental or "passive" tobacco smoke (ETS) exposure in the workplace. These reports are:

[1] The Health Consequences of Involuntary Smoking,[1] a 1986 report of the Surgeon General (hereinafter 1986 Surgeon General's Report);

[2A] Health Effects of Passive Smoking: Assessment of Lung Cancer in Adults and Respiratory Disorders in Children (EPA/600/6-90/006A),[2A] a review draft released by the Environmental Protection Agency (EPA) in 1990 (1990 Draft Risk Assessment);

[2B] Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders (EPA/600/6-90/006B),[2B] a review draft released by the Environmental Protection Agency (EPA) in 1992 (1992 Draft Risk Assessment); and

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two major conclusions which some may urge are relevant to the workplace smoking issue:

> Involuntary smoking is a cause of disease, including lung cancer, in healthy nonsmokers. (p. vii)
>
> The simple separation of smokers and nonsmokers within the same air space may reduce, but does not eliminate, the exposure of nonsmokers to environmental tobacco smoke. (p. vii)

The Surgeon General's review has been challenged by a number of critics. One reviewer, Ann Fettner, suggested that the Surgeon General's conclusions were based on "flimsy" evidence presented in an effort to "divert our attention" from important health concerns such as the "poisoning of the environment."[4] A U.S. Congressman, Walter B. Jones, in a letter published in the Congressional Record, wrote that "the conclusions in the Surgeon General's Report are not supported by the research in his own report."[5] The Surgeon General's conclusions regarding lung cancer, cardiovascular disease, adult respiratory disease, and separation of smokers and nonsmokers are relevant to OSHA's current considerations of the workplace environment and will be discussed below in some detail.

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There are currently 30 spousal smoking studies, 24 of which report risk estimates that are not statistically significant.[9-38] Only six studies report statistically significant increased lung cancer risks for women whose husbands smoke. Thus, these studies taken as a group, or considered individually, do not convincingly support rejection of the null hypothesis of no association between ETS exposure and lung cancer in nonsmokers, and therefore are inadequate as a basis for regulatory action.

Moreover, the vast majority of the spousal smoking studies report risk estimates that are less than 2.0. These values are at the limit of detection for epidemiology. Risk estimates below 2.0 or 3.0 have been described as "weak," and thus, any conclusions drawn from such studies are unreliable.[39] This is particularly true when the studies themselves fail to account for numerous sources of bias and confounding factors. The confounding factors are variables associated with both the classification of "marriage to a smoker" and with risk factors associated with lung cancer, the existence of which can give rise to a spurious ETS-lung cancer association. Examples of confounding factors that are not controlled for in the studies include diet, alcohol consumption, cooking and heating methods, occupation, physical activity, urbanization and socioeconomic class.[40]

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Separation of Smokers and Nonsmokers

The Surgeon General's Report also concluded that "simple separation of smokers and nonsmokers within the same air space may reduce, but does not eliminate, exposure of nonsmokers to environmental tobacco smoke" (p. vii). The Report concludes that smoking bans will not only reduce ETS exposures, but will also "alter smoking behavior and public attitudes about tobacco use" (p. 322). The Report further suggests that "over time, this may contribute to a reduction of smoking in the United States" (p. 322). Thus, the underlying motivation for the use of the ETS/health argument is to attain a "smoke-free society by the year 2000."

The Surgeon General's claim that separation of smokers and nonsmokers does not minimize nonsmoker exposure to ETS is without scientific support. Studies aboard commercial aircraft and in offices indicate, contrary to the Surgeon General's Report, that the simple separation of smokers and nonsmokers effectively minimizes nonsmoker exposure to ETS.[50-57] One recent study, for example, reported that the use of designated smoking areas reduced exposure to ETS by 95 percent.[50] Another study of a smoking-restricted office building reported that ambient nicotine in nonsmoking areas was virtually undetectable, suggesting that ETS had a negligible impact on the nonsmoking areas in the building.[51]

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their measurements of the small airways function of smokers and nonsmokers in the workplace, that nonsmokers exposed to tobacco smoke at work for 20 or more years had reduced function of the small airways compared to nonsmokers who did not have such exposures.[58]

The White and Froeb study has been criticized for numerous reasons, including its assessment of ETS exposure and its method of subject selection.[59-62] Furthermore, White and Froeb themselves noted that the average values of the pulmonary tests of nonsmokers exposed to tobacco smoke "were not notably different" from the values suggested as normal by a specialist in this area.[63] Dr. Michael Lebowitz of the University of Arizona wrote the following regarding the White and Froeb study:[64]

> Even with a biased population, poor study design, and incorrect statistical evaluation, there were no clear-cut, consistent, medically meaningful differences between passive smokers and groups of nonsmokers; a corrected statistical analysis strengthened this conclusion.

Moreover, the Surgeon General wrote:

> The [White and Froeb] study population was self-selected, and the exposure classification was crude and did not account for people who changed jobs. (p. 60)

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> Biases in observation and the [sic] in selection of subjects and the subjects' own expectations may account for the widely divergent results. Studies of large numbers of individuals with measurement of the relevant physiologic and exposure parameters will be necessary to adequately address the effects of environmental tobacco smoke exposure on asthmatics. (p. 65)

Cardiovascular Disease

The Surgeon General's 1986 conclusion on cardiovascular disease and ETS was that further studies "are needed in order to determine whether involuntary smoking increases the risk of cardiovascular disease" (p. 14). In 1988, Fielding, et al., reviewers from the University of California-Los Angeles, who are critical of smoking, conceded that "no firm conclusion that a causal relation exists is yet warranted" for reported ETS exposures and cardiovascular disease.[69] A similar view was expressed in a 1988 review from a Harvard physician, who said that there were "no clear data" that ETS increases heart disease risk.[70]

Several additional evaluations of the literature on ETS and heart disease appeared in 1990. Two of these were reported at international conferences in Lisbon, Portugal[71] and in Budapest, Hungary.[72] Both argued strongly that the data on ETS and heart disease were methodologically weak and insufficient to draw conclusions. In another major review, this one from the United States, two physicians, Drs. Mahajan and Huber, concluded that

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lung cancer deaths per year in the U.S. (the estimate was later revised to 3,700). The Science Advisory Board (SAB) for the EPA reviewed the 1990 Risk Assessment in a meeting in December, 1990. Their report, presented to the SAB Executive Committee in April, 1991, suggested that while further revisions were needed, the conclusions of the Draft were sound.

In May, 1992, the EPA released its revised Draft Risk Assessment on ETS.[2B] The revised Draft Risk Assessment again concluded that exposure to ETS is causally related to lung cancer in adult nonsmokers. The revised Draft also concluded that ETS exposures are causally related to respiratory diseases and symptoms in children and added numerical estimates of risk for various respiratory conditions. The revised Draft Risk Assessment again concluded that ETS should be classified as a Group A ("known human") carcinogen. However, the EPA lowered its estimated number of U.S. lung cancer deaths purportedly attributable to ETS exposure to 3,000 per year. This revised Draft Risk Assessment was reviewed by the EPA's SAB Committee in July, 1992. More charges for revisions were made to the EPA staff, but the committee once again endorsed the Draft's conclusion. An Executive Committee meeting of the EPA-SAB took place in October, 1992. The Executive Committee endorsed the SAB committee's report, and the Draft was sent back to EPA staff for minor revisions.

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risk due to ETS exposure. The PAR for these two assumptions (with other minor adjustments) is 0.27. The total number of deaths for nonsmoking males and females was then estimated, based on the American Cancer Society's projections for 1988 (9,500 total deaths). By multiplying the PAR (0.27) by 9,500, the authors generated an estimate of 2,560 total deaths per year attributable to ETS exposure among neversmokers. A PAR was also computed for male and female former smokers, generating a total estimate of 3,800 excess deaths annually purportedly attributable to ETS exposure among nonsmokers in the United States. Using the same procedure in the 1992 Draft, the authors performed a meta-analysis of the then available eleven U.S. spousal smoking studies and reported a relative risk of 1.19. The calculated cumulative risk generates an estimate of 3,000 excess deaths per year among nonsmokers. The EPA did not modify its 1992 Draft estimate in the final risk assessment document.

The PAR method employs estimates of relative risk, population fractions of exposure to ETS and lung cancer death rates for the general nonsmoking population in order to generate an estimate of excess mortality reportedly attributable to ETS exposure. It is important to note at the outset that the PAR model itself does not determine that there is an increased risk of lung cancer among nonsmokers from ETS exposure. Rather, the model assumes a causal relationship between ETS exposure and an increased risk of lung cancer among nonsmokers, based upon increased risks

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statistical test. The one-tailed test presumes causation: it is designed to show the extent of a purported "effect."

The choice of confidence interval was criticized in a presentation at the October SAB Executive Committee meeting, by James J. Tozzi. In a follow-up letter to the EPA, Tozzi included a meta-analysis of 13 U.S. studies which is not statistically significant using a 95% confidence interval.[76] Tozzi reported a relative risk of 1.07 (95% C.I.: 0.95 to 1.21). Nonetheless, the EPA did not choose to modify their statistical calculations in the final risk assessment document. The main difference between the meta-analysis submitted by Tozzi and the EPA meta-analysis was that the analysis submitted by Tozzi included two recent lung cancer studies that did not report an overall association between spousal smoking and lung cancer in nonsmoking wives. The EPA omitted from its risk assessment the NCI-funded Brownson et al., 1992, study, one of the largest and most recent studies on ETS and lung cancer, which found no increase in risk from exposure to ETS.[77] They also omitted the Stockwell et al., 1992, study.[78] If the EPA had included the Brownson and Stockwell studies in its meta-analysis, its risk assessment would not have resulted in a statistically significant increased risk of nonsmoker lung cancer reportedly associated with exposure to ETS.

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be reported between two factors. For example, because the EPA did not adequately address the potential role of diet, there is a chance that the association the EPA reported between ETS exposure and nonsmoker lung cancer may actually be a result of a common association the two factors may have with poor diet.

The Draft's assumption of causality is based upon tenuous data from epidemiologic studies on spousal smoking. The assumption is the critical element to the PAR model and the original estimate of 3,800 (and revised estimate of 3,000) excess nonsmoker deaths per year reportedly due to ETS exposure. The 1990 and 1992 Draft Risk Assessments fail to argue convincingly for the assumption. Without the causal assumption, the PAR approach is little more than an exercise in mathematical modeling.

The conclusions of the 1990 Draft Risk Assessment were strongly criticized, particularly in many of the more than 100 comments submitted during the public comment period on the draft.[75] Specifically, many of the public comments found EPA's classification of ETS as a Group A carcinogen to be scientifically unwarranted.

One point of criticism was that the EPA's proposed classification of tobacco smoke as a "human carcinogen" was based in part upon the imputed identification and presence in ETS of suspected carcinogens reported in mainstream smoke and/or fresh

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Another major criticism of the 1990 Draft Risk Assessment was that in addition to its inadequate treatment of the data on the physical and chemical properties of ETS, it also virtually ignored the available exposure data, toxicological data and data from animal studies on ETS. The 1992 Draft similarly failed to consider these data. For instance, not one of the spousal smoking studies included actual measurements of ETS exposure; exposure was only estimated by responses to questionnaires. However, a large body of literature exists on actual measurements of ETS in indoor environments, which was not considered in the 1990 Draft Risk Assessment and only cursorily considered in the 1992 Draft.[52,79,87-90] While these data are independent of the epidemiologic literature, they suggest that nonsmoker exposure to ETS in typical public places and workplaces is minimal.[52,87-90] For example, some studies report typical measurements of nicotine ranging from an exposure equivalent of 1/100 to less than 1/1,000 of one filter cigarette per hour.[56,91-97]

While a docket for written comments was not established for the 1992 Risk Assessment, oral comments were allowed at both the July SAB committee and the October Executive Committee meetings. However, commenters were asked not to reiterate previous points of discussion. One major issue raised by Dr. William J. Butler in July was the EPA's treatment of confounders.[98] The EPA took the position that confounders could not account for the reported

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and that all possible biases and possible confounding factors are to be considered.

Thus, the conclusions of the EPA's 1990 and 1992 Draft Risk Assessments are based on an incomplete and selective review of the existing data on ETS. Several of the public comments on the 1990 Draft suggested that this amounted to EPA's apparent failure to follow its own guidelines for carcinogen risk assessment.[75] In fact, the EPA would not have classified ETS as a Group A carcinogen had the EPA used the methodologies and guidelines it employed in all its previous risk assessments.

NIOSH Current Intelligence Bulletin

In June 1991, NIOSH released Current Intelligence Bulletin 54 on environmental tobacco smoke.[3] The NIOSH CIB stated that:

> NIOSH has determined that the collective weight of evidence (i.e., that from the Surgeon General's reports, the similarities in composition of MS and ETS, and the recent epidemiologic studies) is sufficient to conclude that ETS poses an increased risk of lung cancer and possibly heart disease to occupationally exposed workers. (p. 12)

In the excerpt above, the CIB refers to three areas that contribute to its "collective weight of evidence." The Surgeon

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The final aspect of NIOSH's "weight of the evidence" is "recent epidemiologic studies" on ETS and lung cancer. However, its review of the spousal smoking studies is incomplete. The CIB states that eight additional spousal smoking studies have been published since 1986, when, actually, 14 have been published, most of which report associations which do not achieve statistical significance. Furthermore, the CIB acknowledges serious shortcomings in the available epidemiologic studies purporting to relate ETS exposure and lung cancer:

> NIOSH recognizes that these recent epidemiologic studies have several shortcomings: lack of objective measures for characterizing and quantifying exposures, failure to adjust for all confounding variables, potential misclassification of ex-smokers as nonsmokers, unavailability of comparison groups that have not been exposed to ETS, and low statistical power.

Nevertheless, the CIB uses spousal smoking studies to reach its conclusion about occupational exposure to ETS without justifying the relevance of spousal smoking studies to workplace exposure. Of the spousal smoking studies, none actually measured levels of ETS to which the subjects ostensibly were exposed. The NIOSH CIB also fails to address the 12 spousal smoking studies that included specific questions about workplace exposure.[9-20] Of those studies, ten reported no statistically significant increased risk of lung cancer for nonsmokers who reported ETS exposure in

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Of even greater significance, it does not address available workplace data on exposures or potential health effects.

Other Risk Assessments on ETS

Two basic methods (modeling procedures) for estimating the population risk for lung cancer among nonsmokers reporting exposure to ETS have appeared in the scientific literature. The first method, adopted by the U.S. EPA in its Draft Risk Assessment (discussed above), is the Population-Attributable Risk (PAR) approach. A PAR model seeks to establish an estimate of excess risk due to ETS exposure and is expressed as a ratio of the risk assessed for ETS to the total lung cancer risk for nonsmokers from all sources. The PAR is calculated by applying a relative risk estimate associated with reported exposure to ETS (derived from risk rates in epidemiologic studies) to the percentage of individuals believed to be exposed to ETS in the general population.

A second approach used in the literature, called the Extrapolation Method (also called the Linear Extrapolation Method or Dose-Response Extrapolation Model), combines reported risks o lung cancer for active smokers, derived from epidemiologic studie on smokers, with estimates of tobacco smoke exposure (dose) fo active smokers. The risk and dose estimates for active smoker are then extrapolated downward to apply to nonsmokers. Th

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weighted average of nonsmoker exposure to particulates. The weighted average estimate was not derived from actual exposure data but from a model which predicts ambient concentrations of particulate matter from the number of cigarettes smoked in a given volume of air space. The authors also calculated a lung cancer risk estimate and an estimate of daily "tar" (particulate) intake for active smokers. Nonsmoker risk of lung cancer was extrapolated from those estimates to yield 555 lung cancer deaths per year attributable to ETS exposure among nonsmokers.

Arundel, et al., (1987) refined the Repace and Lowrey extrapolation model by replacing Repace and Lowrey's estimates of particulate matter exposure for nonsmokers with actual exposure data from monitoring studies.[101] The Arundel, et al., model also rejected Repace and Lowrey's extrapolation from the dose of active smokers to the exposure of nonsmokers, and replaces the latter with an estimated retained dose of particulates for nonsmokers. Using virtually the same assumptions as Repace and Lowrey, the Arundel et al. model estimates 12 lung cancer deaths per year among 40 million male and female neversmokers.

The various assumptions and estimates employed in the Repace and Lowrey linear dose-extrapolation model have been challenged by a number of scientists.[101-105] One scientist noted that the exposure and dose levels Repace and Lowrey used were not

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Even with its dubious assumptions and estimates, it is noteworthy that the linear dose-extrapolation model produces estimates of excess lung cancer deaths which are roughly an order of magnitude lower than estimates generated by the PAR model which relies on epidemiologic studies. A number of subsequently published extrapolation models, unlike that of Repace and Lowrey, have been based upon actual data and reasonable estimates of exposure.[101,106-108] These models have been unsuccessful in estimating any appreciable increased risk of lung cancer for nonsmokers reporting exposure to ETS. Indeed, extrapolation models based on estimates of retained particulate matter generate estimates of excess risk which are as much as 20 orders of magnitude lower than estimates generated by the PAR method. Such vast ranges underscore the difference between risk estimates based on epidemiology and those based on dosimetry. This difference is so striking that even the authors of the EPA Draft Risk Assessment were unable to generate a "dose-response based on the extrapolation from mainstream to environmental tobacco smoke," and hence, relied solely upon the PAR model to support their contention of an increased risk of lung cancer among nonsmokers reportedly exposed to ETS.[109]

There have been two published risk assessments of environmental tobacco smoke (ETS) exposure and heart disease, the first by A. Judson Wells in 1988,[110] and the second by Kyle

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a value of actual numbers of deaths related to ETS exposure, these excess death rates were multiplied by the number of people in the U.S. estimated to be exposed. Based on such calculations, Wells estimated that ETS exposure produced 39,000 excess deaths per year in the U.S.

Further calculations attempted to take into account misclassification, either of smokers as nonsmokers or of nonexposed nonsmokers as exposed to ETS. Wells calculated that these adjustments for misclassification resulted in a revision upward of the estimate, from 39,000 to 53,000. Wells then stated that a more "conservative" estimate would be 46,000, a value chosen because it is halfway between the unadjusted value of 39,000 and the adjusted value of 53,000.

It is clear that the claim of 53,000 excess deaths associated with ETS exposure is assailable at every level of its derivation. At the most fundamental level, the studies contributing to the meta-analysis are scientifically flawed. The flaws stem from, among other reasons, small sample sizes, inadequate control for potential confounding factors and unreliable estimates of ETS exposure. Such flaws contribute to the invalidity of the subsequent meta-analysis, a technique which is further called into question because it is not designed to bring together such methodologically disparate studies. Furthermore, any overall estimate of the

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population. Second, he focused only on heart disease and did not attempt to calculate ETS-related deaths from other diseases.

Other than the above, Steenland's procedure for calculating deaths attributable to ETS exposure was generally similar to that reported by Wells. This estimation process involved: positing an overall increase in relative risk of heart disease associated with ETS exposure; making adjustments for potential misclassification and for background exposure; estimating the extent of exposure to ETS; and estimating the fraction of nonsmoker heart disease deaths attributable to ETS exposure. These estimates were incorporated into a formula using data on U.S. heart disease death rates and population estimates, from which was derived an estimated number of annual heart disease deaths attributed to ETS exposure. According to Steenland's calculations, "the overall estimate of ETS-attributable heart disease deaths for never-smokers and former smokers is 35000 to 40000." He further commented that these increased risks of death "are higher than those accepted in regulating environmental toxins."

Steenland's calculations involved problems similar to those that plagued Wells' attempt to derive a number of deaths associated with ETS exposure. Although Steenland cannot be criticized for performing an invalid meta-analysis (because he did no meta-analysis at all), his procedure can perhaps be criticized

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